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ABSTRACT

This experiment was designed to investigate the possibility that young children use syntax to constrain and focus verb meanings in their interpretations of novel scenes and novel verbs. Subjects were 24 children, 12 males and 12 females, of 23 to 27 months, all raised in English-speaking homes. Their mean productive vocabulary was 240 words. A total of 17 had produced utterances of three words or longer; 7 were in the two-word stage of language development. Each child viewed simultaneously presented video events. Between the video monitors, an auditory speaker played a message that matched only one of the video events, or scenes. It was expected that if the utterance was correctly understood, the child would look preferentially at the scene that was consistent with the utterance. If the utterance was not understood, it was expected that the child would look randomly at either scene. For each of the subjects, a pattern of teaching and testing was repeated for four nonsense verbs. Half of the children heard each verb presented in the transitive audio, and the others heard each verb presented in the intransitive audio. Findings provide strong support for the syntactic bootstrapping hypothesis proposed by Landau and Gleitman (1985). (RH)

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SYNTACTIC BOOTSTRAPPING: A PARTIAL SOLUTION TO THE INDUCTION PROBLEM OF VERB LEARNING

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SYNTACTIC BOOTSTRAPPING: A PARTIAL SOLUTION TO THE INDUCTION PROBLEM OF VERB LEARNING

How do young children learn verb meanings? Clearly, they can gather a lot of information by observing visuo-spatial scenes and pairing these with words heard in the input. However, such real-world scenes can often be uniformative or misleading to the unbiased learner. For example, the child who hears "oh! bringing!" while observing the action of bringing (for example, Adam bringing the truck to Mom), may also be observing coming/walking (Adam is coming/walking to Mom with the truck, Adam and the truck are coming to Mom), getting/ taking (Mom is getting/taking the truck from Adam), playing (Adam is playing with the truck), and so forth. How is the child to determine which interpretation is the correct one? Because of the plurality of choices the real-world scene provides, verb learners must be using more information than is present in the observed scene. This paper presents evidence about another source of information for verb learning; namely, the information in the syntactic structure.

Linguists and psychologists have theorized that words which differ systematically in meaning also differ systematically in the kind of sentence structures they appear in. (cf. Chomsky, 1981, Kaplan and Bresnan, 1982). For example, there exists in English a fairly straightforward relation between transitive frames and causative meanings. Briefly, English verbs which involve causation generally appear in transitive sentences (containing a direct object):

(1) "Adam burns the candle"

(roughly glossed as [Adam causes the candle to burn]). Correspondingly, verbs in intransitive sentences (without a direct object) generally do not include the notion of causation;

(2) "The candle burns."

The basis for this linkage is fairly transparent: Since causal events involve both a causal agent (Adam) and a thing affected by the action (the candle), two noun-phrases (NPs) are needed in the sentence; hence, the transitive structure. In intransitive sentences, only one NP is present, so the cause of the event (if any) cannot be expressed.

It is such regularities or linking rules (Pinker, 1987, Levin, 1985) between syntax and verb semantics that have been proposed as another source of information for child verb learners. In what Landau and Gleitman have dubbed the Syntactic Bootstrapping hypothesis, these regularities between verb meaning and sentence structure could be exploited to narrow down the possible meanings of specific verbs. For example, attention to the transitive-intransitive distinction in surface structure could inform the child as to the causal nature of an action described by an unfamiliar verb. In this way, syntactic bootstrapping would enable the child to choose between the several interpretations allowed by observation.

The results of past research suggest that children know (implicitly) some of these regularities between their syntactic and semantic databases. Bowerman (1974, 1977, 1983) has provided compelling data from the spontaneous speech of her own young

children suggesting that, given knowledge of the meaning of a verb, learners are willing to make predictions about the syntactic structures in which these verbs will appear. For example, children will extend the transitive-causative relationship to new cases. If they have heard "The lion falls", they sometimes will utter "The horse falls the lion" as a way of saying that the horse causes the lion to fall. This evidence suggests that children can make predictions about sentence structure, given a particular verb meaning; in this case, one involving causation. There is also evidence that the opposite can also occur: that children can conjecture new meanings for verbs, based on the presentation of new syntactic frames. A recent study by Naigles, et. al. (1988) presented two-, three-, and four-year old children with ungrammatical sentences to act out; these contained known verbs in prohibited frames (e.g.,*"the zebra goes the lion."). The children used the information encapsulated by the frame (e.g., causation for the transitive frame) to extend the meanings of the verbs placed in them. That is, they performed causative actions for verbs in ungrammatical transitive sentences, and noncausative actions for verbs in ungrammatical intransitive sentences (e.g., *"The zebra brings to Noah."). Thus, verb extension can proceed from form to meaning as well as from meaning to form.

The purpose of the present experiment was to test the Syntactic Bootstrapping hypothesis more directly. Since the verbs used in the Naigles et al. experiment were common ones, the children were reinterpreting familiar verbs on the basis of novel syntactic frames, but they were not actually learning verbs. This experiment was designed to investigate whether young children can in fact use

the syntax to constrain and focus verb meanings in their interpretations of novel scenes and novel verbs. In this experiment, the child was presented with two novel actions--one causative, the other noncausative--but only one novel verb. The child's job was to figure out which action represented the new verb. The question asked was whether the sentence frame in which the verb was presented would determine which action was chosen for the verb. For example, if the frame was transitive ("the duck is blicking the bunny"), would she choose the causative action?

METHOD

This experiment utilized the preferential looking paradigm recently developed by Roberta Golinkoff and Kathy Hirsh-Pasek (1985, 1987). This is a more sensitive language comprehension paradigm than the more common "acting-out" method, because it simply requires the child to look at one of two simultaneously presented video events. If the utterance the child hears is understood correctly (i.e., according to the rules of English), then she would presumably focus on the one scene that is consistent with that utterance. If the utterance is not understood, the child would presumably look randomly at either scene (assuming neither is particularily salient).

Subjects

The subjects were 24 children, twelve males and twelve females, all raised in English-speaking homes. They were between the ages of 23.0 and 27.0 months, with a mean age of 25.3 months. Their mean productive vocabulary was 240 words (out of a possible 354 on

Rescorla's (1985) vocabulary checklist). Seventeen of them had produced (by maternal report) three-word or longer utterances, while seven were still in the two-word stage.

Apparatus

The basic set-up is shown in Figure 1 (SLIDE). The child was seated on the mother's lap and observed two different, simultaneously presented, video events on two side-by-side video monitors. Between the two monitors, an auditory speaker played a message that matched only one of the video events, or scenes. On top of the speaker was a ten watt light bulb that lighted between trials to attract the child's attention. Children were placed two feet back from the center of the two video displays. The dependent variable is the child's visual fixation to the two monitors; this was recorded by hidden observers, who were blind to the experimental condition. Data from the observer were collected and tabulated by an Apple IIe computer. The mother was also blind to the experimental condition, as she wore a visor over her eyes while in the testing room.

Stimuli and Design

The stimulus displays were pairs of color videotapes. A schematic depiction of the videotapes and the audio match is presented in Table 1 (SLIDE). The left and right columns indicate videos, while the center column indicates the audio. Each trial is anticipated by a linguistic stimulus that begins during the central fixation period; that is, the child hears each audio twice: once when the screens are blank, and then again three seconds later when the actions appear. First, an

introductory passage familiarized the subjects with the situation and the characters (see Table 3 for the complete sequence), and then, the test of syntactic bootstrapping began. The crucial sequence was as follows. In trial 1, both screens present a Multiple Scene--two actions going on simultaneously. One of the actions is causative (the duck forcing the rabbit into an odd bending position), and the other is noncausative (the duck and the rabbit making arm gestures). The accompanying audio presents a novel verb--"gorp"--in a sentence. This verb is either in a transitive frame, e.g.,"Look! The duck is gorping the bunny" or in an intransitive frame, e.g., "Look! The duck and the bunny are gorping." This presentation of novel actions and a novel verb occurred three times for each verb.

Next, the two actions are separated into Single Action Scenes (trial 2 in Table 1): one screen shows only the causative action of the duck forcing the rabbit into the odd bending position, while the other screen, displayed at the same time, shows only the duck and the rabbit making the arm gestures. This control trial (whose audio is "Oh! they're different now!") serves two purposes. First, it permits the child to inspect the two alternatives before the directive audio is introduced, but more importantly, it provides us with a measure of stimulus salience. In order for the test data to be interpreted unequivocally, neither member of a control trial should receive significantly more attention.

Finally, the test trials (trials 3 and 4) are presented. The Single Action Scenes appear again, paired with the test audio, "Find gorping now!" These trials test what the children learned from the

initial teaching phase; for example, if the transitive audio did direct their attention to the causative action, they should look longer at this action when asked to "find gorping". Each test trial was presented twice.

This pattern of teaching and testing was repeated across four nonsense verbs for each of the subjects. Half of the children heard each verb presented in the transitive audio (e.g., "The duck is gorping the bunny!"), and the other children heard each verb presented in the intransitive audio (e.g., "The duck and the bunny are gorping!"). The side of the matching screen was counterbalanced both across subjects, by varying the placement of the tapes in the video tape decks, and within subjects, by constructing the tapes so that the match occurred equally on the left and right sides.

RESULTS

The main question concerned the within-subjects factor of the screen: did the children fixate longer at the screen that matched what they heard? That is, did the children who heard the novel verbs presented in the transitive audio choose to focus on the screen showing the causative action during the test trials? Likewise, did the children who heard the novel verbs presented in the intransitive audio choose to focus on the screen showing the noncausative action during the test trials? This pattern of results would follow the predictions of the Syntactic Bootstrapping hypothesis. Alternatively, if the children could not use syntactic structures to focus on verb meanings, they should look randomly back and forth at the screens showing the causative and noncausative

effects, in that the transitive audio elicited a preference for the causative action, and the intransitive audio yielded a preference for the noncausative action.

DISCUSSION

This paper began with the question, How are the meanings of words, and more specifically verbs, learned by children? The syntactic bootstrapping hypothesis proposed by Landau and Gleitman (1985, Gleitman et al., 1987; see also Naigles et. al., 1988) suggested that one source of information about verb meanings resides in the syntactic frames in which the verbs are presented. The results of this experiment provide strong support for this hypothesis, as they show that the syntax of the input sentence can focus the child's interpretation of the scene, and so influence her selection of the action in the scene that the verb refers to. Specifically, the children who heard novel verbs in transitive frames seemed to believe (as measured by their visual fixation) that the verbs referred to the causative (or perhaps, more general "acting-on") actions, while the children who heard the same novel verbs in intransitive frames seemed to believe that the verbs referred to noncausative actions.

These results extend the findings of the earlier studies in two important ways. First, if syntactic bootstrapping is to be a significant force in verb learning, it should be operative for children when they encounter <u>new</u> verbs. Indeed, the children in this study were able to use the syntax to determine the meanings (or at least the referents) of novel verbs; this seems closer to the

actual verb learning scenario than extending the meanings of familiar ones. Secondly, syntactic bootstrapping should be operative early in the acquisition process: a cause, not just an effect, of verb learning. We see that the subjects in the present experiment were younger than any of those previously studied. At just two years of age, they are constantly engaged in the learning of new verbs (Brown, 1973). Thus, this study provides direct evidence that syntax can be a powerful source of information for verb learners who must infer the referents of novel verbs.

I would like to close by mentioning several interesting questions that remain, even with this initial validation of syntactic bootstrapping. For example, nothing has been said about how the regularities or linking rules, insofar as they differ across languages, are acquired; this is clearly a crucial point for a theory which presupposes some linguistic knowledge to begin with. Finally, this research (and much of the acquisition research concerned with syntax-semantics relations) has focussed on the transitive-causative link in English; a challenge for the future will be to show that other elements of verb meaning can be learned via syntactic evidence.

BIBLIOGRAPHY

Bowerman, M. (1974) Learning the structure of causative verbs: a study in the relationship of cognitive, semantic, and syntactic development, PRCLD 8, 142-178.

Bowerman, M. (1977) The acquisition of rules governing "possible lexical items:" evidence from spontaneous speech errors, PRCLD 13, 148-156.

Bowerman, M. (1983) Evaluating competing linguistic models with language acquisition data: implications of developmental errors with causative verbs, Quaderni di Semantica 3, 5-66.

Brown, R. (1973) A First Language. Cambridge: Harvard University Press.

Chomsky, N. (1981) Some Concepts and Consequences of the Theory of Government and Binding. Cambridge, MA: MIT Press.

Gleitman, L.R., Gleitman, H., Landau, B. and E. Wanner (1987) Where learning begins: Initial representations for language learning. In F. Newmeyer, ed., The Cambridge Linguistic Survey Vol. 3, Cambridge: Cambridge University Press.

Golinkoff, R., Hirsh-Pasek, K., Cauley, K. and L. Gordon (1987) The eyes have it: lexical and syntactic comprehension in a new paradigm. Journal of Child Language 14, 23-45.

Jackendoff, R. (1983) Semantics and Cognition. Cambridge, MA: MIT Press.

Jackendoff, R. (1985) Multiple subcategorization and the theta-criterion: the case of climb. Natural Language and Linguistic Theory 3, 271-295.

Kaplan, R. and J. Bresnan (1982) Lexical-functional grammar: a formal system for grammatical representation. In J. Bresnan The Mental Representation of Grammatical Relations. Cambridge: MIT Press.

Landau, B. and L. Gleitman. (1985) Language and Experience. Cambridge, MA: Harvard University Press.

Levin, B. (1985) Lexical semantics in review: an introduction. In B. Levin, ed., Lexical Semantics in Review. Lexicon Project Working Papers, 1. Cambridge, MA: MIT Center for Cognitive Science.

Naigles, L. (1988) Syntactic bootstrapping as a procedure for verb learning. Unpublished Ph.d. dissertation. University of Pennsylvania.

Naigles, L., Gleitman, H., and Gleitman, L.R. (1988) Syntactic bootstrapping in verb acquisition: Evidence from comprehension. In E. Drome, Ed., Language and Cognition: A Developmental Perspective. Norwood, NJ: Ablex. In press.

Pinker, S. (1984) Language Learnibility and Language Development. Cambridge, MA: Harvard University Press.

Pinker, S. (1987) Resolving a learnability paradox in the acquisition of the verb lexicon. Working Papers 17, MIT Lexicon Project.

Quine, W.V.O. (1960) Word and Object. Cambridge, MA: MIT Press.

Rescorla, L. (1985) Identifying language delay at age 2. Paper presented to the Society for Research in Child Development.

Talmy, L. (1975) Semantics and syntax of motion. In J. Kimball, ed.,Syntax and Semantics Vol. 4 New York: Academic Press.

Talmy, L. (1980) Lexicalization patterns: semantic structure in lexical forms, In T. Shopen, et. al., eds. Language Typology and Syntactic Description. New York: Cambridge University Press.

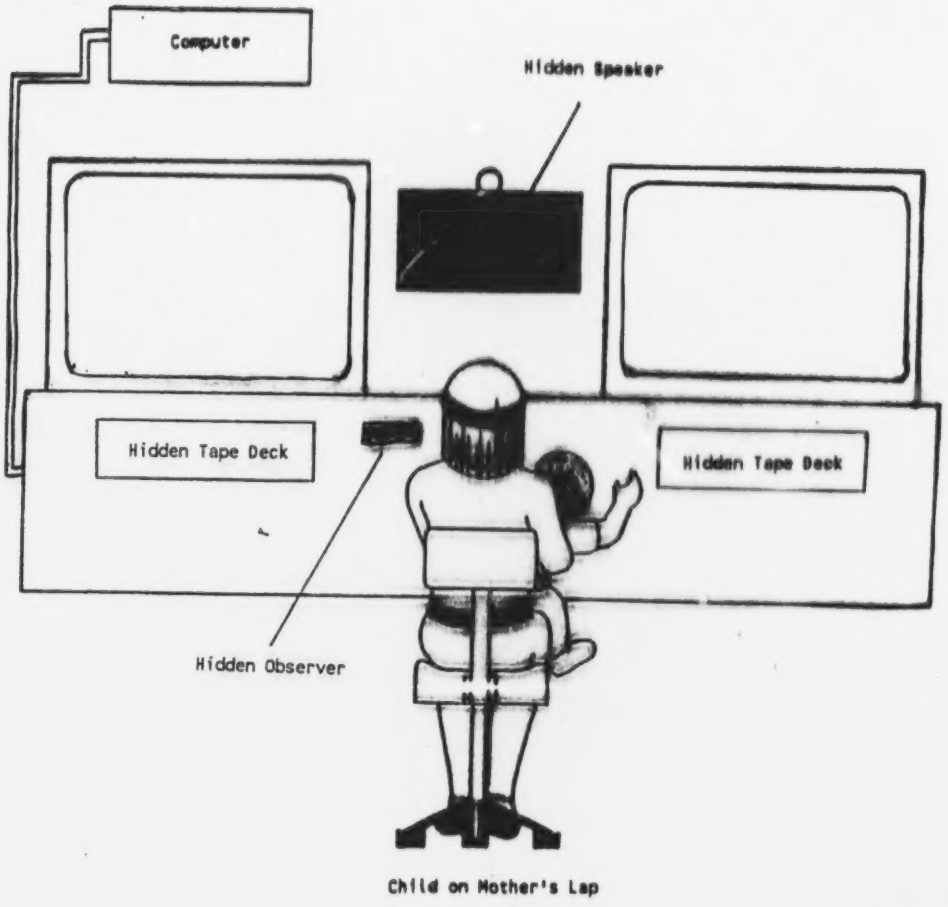

Computer
Hidden Speaker
Hidden Tape Deck
Hidden Tape Deck
Hidden Observer
Child on Mother's Lap

Fig. 1

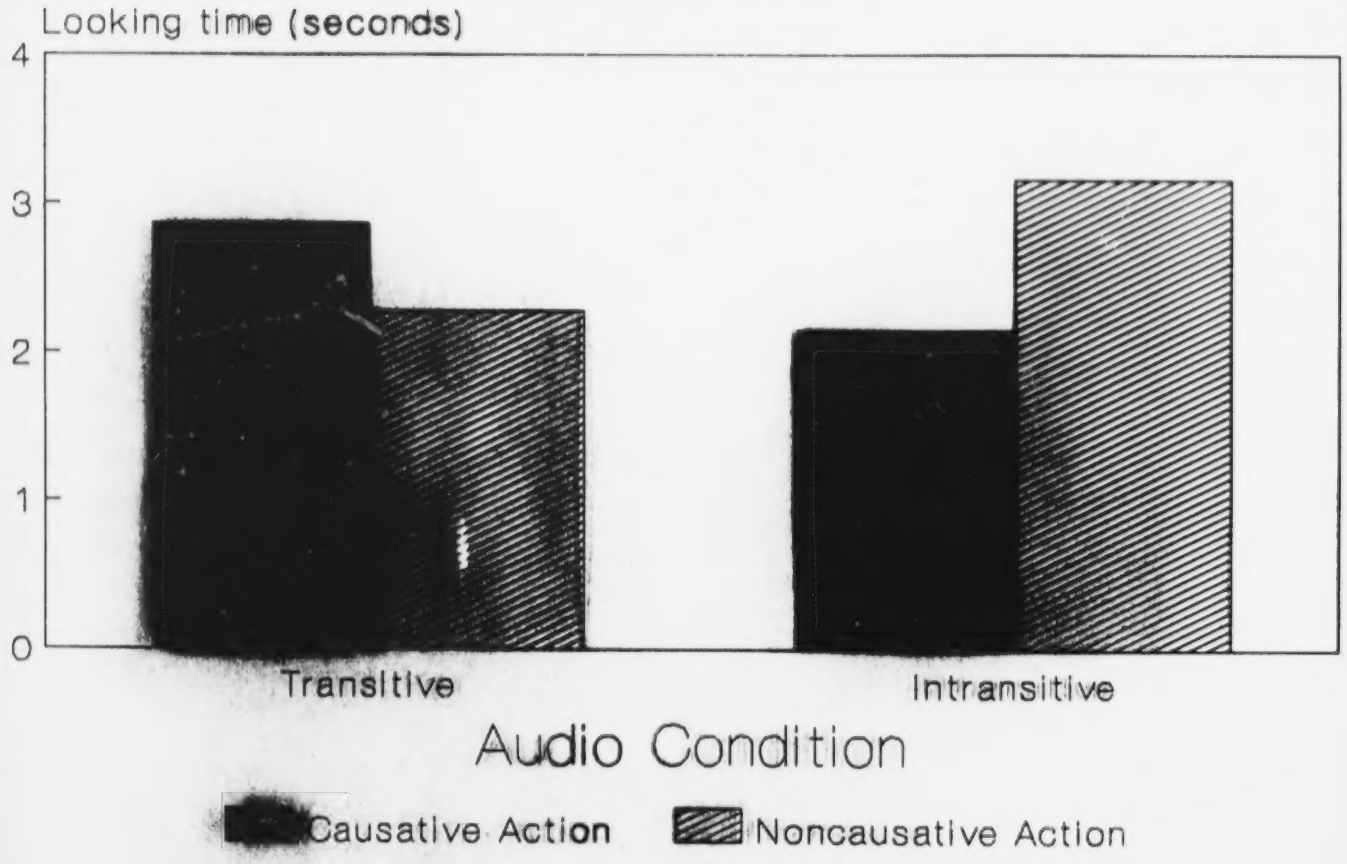

Looking time (seconds)
4
3
2
1
0
Transitive
Intransitive
Audio Condition
Causative Action
Noncausative Action

Fig. 2

TABLE 1

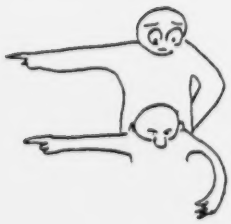
Trial	TAPE 1	AUDIO	TAPE 2
1		Look! The duck is blicking the bunny!	
2		Oh! They're different now!	
3		Find blicking now!	

TABLE 2

Causative and Noncausative Actions associated with each Verb

VERB	Causative	Noncausative
GORP	Duck forces rabbit into bending position	Duck and rabbit flex own arms
BLICK	Rabbit makes duck pat duck's head	Rabbit and duck lift own legs
KRAD	Rabbit makes duck tilt duck's head	Duck and rabbit make arm circles
DAX	Duck lifts rabbit's leg	Duck and rabbit cover own eyes with own arm

APPENDIX

Complete sequence of trials in preferential looking paradigm

Layout of Videotape

Tape 1	Audio	Tape 2
CHARACTER IDENTIFICATION SEGMENT		
1 Duck waves	Where's the duck?	Rabbit waves
2 Duck waves	Where's the bunny?	Rabbit waves
3 Duck waves	Find the bunny!	Rabbit waves
4 Duck waves	Look at the duck!	Rabbit waves
SYNTACTIC BOOTSTRAPPING SEGMENT		
5 The duck is forcing the rabbit into a bending position; Both are making arm gestures	Look! The duck is gorping the bunny!	Black
6 Black	Look! The duck is gorping the bunny!	Duck is forcing the rabbit into a bending position; Both are making arm gestures
7 The duck is forcing the rabbit into a bending position; Both are making arm gestures	Look! The duck is gorping the bunny!	Duck is forcing the rabbit into a bending position; Both are making arm gestures
8 The duck is forcing the rabbit into a bending position	Oh! They're different now!	The duck and the rabbit are making arm gestures
9 The duck is forcing the rabbit into a bending position	Where's gorping now?	The duck and the rabbit are making arm gestures
10 The duck is forcing the rabbit into a bending position	Find gorping!	The duck and the rabbit are making arm gestures